Using a Comprehensive Community Health Information System for Public Health Planning and Program Delivery

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Abstract

Across Canada and elsewhere, health care systems are regionalizing and devolving local authority for health care delivery, financing, and management. Increasingly, regional health authorities find they need better tools for health care planning and decision-making to increase efficiency and effectiveness of service delivery. In order for information to be useful for this purpose, it needs to be timely, relevant, and available in sufficient detail in a flexible manner to decision-makers and planners. Information technology is being enthusiastically seen as a critical tool for addressing various needs of decentralized regional health authorities. Technological innovations combined with data are being increasingly sought for meeting various needs such as health status assessments, integrated planning, clinical and programmatic decision-making, evaluation of outcomes and targets, and dissemination and communication. Data output, whether as hard copy or via intranet or the Internet, needs to be customized according to the user (board member, administrator, manager, staff, the public) and according to the intended use (planning, evaluation, report, research). Data can be presented in tables, charts, graphs, or maps to make output more understandable and relevant to local contexts. This paper describes an initiative underway in a regional health authority (Saskatoon District Health) in Saskatchewan, Canada, to create a comprehensive community health information system (CCHIS) for the district. The purpose of the CCHIS is to provide a database system that supports and enhances a broad range of activities and functions in the district at all decision-making levels.

Keywords: health information systems, regional health authorities, health planning and evaluation

Introduction

As virtually all provinces in Canada move to either decentralized or devolved governance of the health care system, the need for reliable and relevant information at the local level for decision-making has become greater than ever. The information is needed for a variety of decision-making functions mandated to the regional boards, such as local planning, setting priorities, allocating resources, and managing and delivering services. In larger regional jurisdictions (such as capital health authorities), this information requirement may be satisfied in a number of ways, but smaller health districts have fewer options. Furthermore, from the perspective of the regional health authorities, it is more desirable if the information is generated locally, and managed or

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controlled locally. This report describes an initiative underway by Saskatoon District Health (SDH) (Saskatchewan, Canada) to respond to this challenge by creating a comprehensive community health information system (CCHIS) for the district.

Health Information System Goals and Objectives

SDH's Strategic Health Information and Planning Services Department has a mandate to take information from many areas (research, service utilization, health determinants, behaviors and outcomes, and policy trends) and, by a variety of means (analysis, interpretation, dissemination in a variety of formats), turn this into knowledge for use in planning, evaluation, and policy-making. The department consists of three divisions—Research Services, District Health Services Utilization, and Population Health Surveillance Units.

The CCHIS is a key tool for all of these units to use in supporting the decision-making functions mandated to the SDH. Specifically, the CCHIS will enable strategic decision-makers to identify population health needs and prioritize these needs, configure health care delivery systems, promote cross-sectoral partnerships for health improvement, and evaluate and monitor service utilization and health outcomes. A key component of the CCHIS is the linkable (relational) database, which assembles data from multiple sources, within as well as outside the health sector, and is supported by appropriate information technologies and tools for end-user analysis, including the use of a geographic information system (GIS).

The objectives of the CCHIS are to:

- Enhance strategic decision-making by improving the quality of data used, expanding the breadth of relevant data available, and presenting information in an easily understandable manner.
- Facilitate the use of evidence in planning and delivery of services by making information directly available (e.g., online) to key staff members in the district.
- Ensure consistent, timely, and efficient data delivery by assembling and managing a single repository that incorporates a variety of sources and elements of data.
- Increase staff's skills in the analysis, interpretation, and application of information in planning by providing training in the principles of data use, attributes of the database, and analytical tools.
- Promote partnerships within the district health system and between the health system and other key sectors by sharing data, information, and other resources.
- Contribute to the research literature by conducting studies and communicating findings of original research.

Context and Concept

SDH Background

Established in 1992, SDH serves a population of 230,000. A majority of the population lives in the urban center of Saskatoon, while others reside in the surrounding small towns and rural area. Over the six years since its establishment, SDH has achieved sig-

nificant integration of health services and is now directly responsible for providing acute care, long-term care, rehabilitation, home care, mental health services, addiction services, and public health services to district residents. In addition, SDH also has affiliation agreements with several surrounding predominantly rural health districts for providing public health services.

Conceptual Model

The conceptual model we have adapted is from Roos et al. (1), originally developed by Evans and Stoddart (2). This model is helpful primarily in two ways. First, it defines the scope of what is meant by health, its determinants, and its consequences. This enables us to establish the rationale for selection of a wide array of data sources and specific measures from these sources representing each of the three dimensions—health and function, determinants of health, and consequences of threats to health. Second, this model helps us understand how determinants are linked with health status, and how health status is linked with the consequences of health problems. In other words, the conceptual model being adapted depicts how the concepts of determinants, health, and consequences of ill health may be linked with each other.

Specifically, the conceptual model combines a range of environmental factors (both external as well as internal environments) that influence and are influenced by individual responses, which in turn lead to manifestations of health and well-being. These individual responses are of many types, with two of the main types being behavior (e.g., smoking, physical activity, diet) and psychosocial factors (e.g., social support, self-esteem). Health status and, more specifically, threats to health, again are mediated by individual responses (e.g., help-seeking behavior, perception of need, and availability of services), which affect demand and use of health care services. Health care services and, in particular, their effectiveness, lead to new outcomes—restoration or rehabilitation of health status and well-being—thereby feeding back into the model in an iterative manner.

Community Health Information System

The proposed CCHIS is conceived as a dynamic system. The system will continually collect, analyze, and present information in a usable form for decision-makers. For example, using the system, we can produce detailed reports every few months, scholarly papers and articles, and timely broadsheets showing current figures and trends in selected topic areas. All these products go into making up a data-driven information system that is closely linked with an evidence-based health planning and decision-making system.

The CCHIS is, technically, a network of information systems from the provincial level through to the regional and the local levels (i.e., sub-district level), each connecting "up" as needed for district-wide use. This type of information system requires organizational change and is enabled by today's information technology. It relies on the use of computers and communication technology to decentralize information and communicate it to the appropriate points of use (e.g., service delivery, monitoring, planning, and evaluation).

The CCHIS will include an extensive communication network capability to link together various entities within the system-utilization management, the providers of

public health and institutional-based services, affiliate health care organizations, and the provincial, regional, and local governments. These connections will enable the organizations to communicate with each other, exchange data, and have access to views of pre-analyzed information in a highly secure and timely manner. The communication technology will enable the networking of entities within the health care system and, in some instances, outside the system in a seamless way that helps them to function as a whole interactive system. This linkage is an important part of the underlying infrastructure.

Another important part of the infrastructure is the data repository. The CCHIS will assemble a diverse range of data on the health status and health determinants of the population. These data will be linked and available in pre-analyzed format as well as for ad hoc analysis. This data repository will serve as the basis for a wide variety of functions including regular production of health status monitoring reports, needs-based planning documents, resource allocation, evaluation, and utilization and outcome research.

The proposed CCHIS will have the following three main functions:

- Assembly of existing health data on the population, mortality, morbidity, supply of hospitals and health professionals, utilization of services, and more. Some qualitative data on public expectations and preferences will need to be collected.
- Analysis of data to produce health information on the needs, preferences, and health status of the population. Closely related is the function of synthesis and interpretation of the information to produce evidence, spelling out the implications for health planning, services, research, and policy-making.
- Dissemination of the results to decision-makers and the general public.

The CCHIS itself will not make policy decisions, but will notably enhance the factual basis of the organization and its partner agencies for decisions regarding planning, allocation of resources, what services to provide, and what research areas to pursue.

As important as it is to generate regular and timely reports for decision-makers, this function in and of itself is an incomplete conception of the CCHIS. The system is conceived to allow sufficient flexibility to enable a "participatory dialogue" between those who produce the information and those who utilize it (i.e., decision-makers, planners). This dialogue includes, as part of the operational processes, a re-channeling into the CCHIS data collection system of information gathered as a result of using the data by the decision-makers.

For example, along with fact sheets and regular reports disseminated to a wide range of individuals, we will include brief questionnaires seeking views on the usefulness of the system processes and feed them back into the design of the data collection. There are two key issues on which regular feedback would be valuable: first, how the findings are being used, and second, how the findings should be presented, and to whom. Both of these issues are at the heart of the challenge for effective dissemination, and technology provides a vital tool for its solution. The technology allows information and findings to be presented in ways ranging from informative paper-based graphics to interactive programs via intranet systems. Thus, the functions of information production and evaluation of its usefulness are built into the system.

Potential Uses of Data

The potential uses of the CCHIS are many, ranging from health status monitoring, aiding in needs assessment and all other stages of a planning cycle, to research, broadly defined. Correspondingly, the potential users of information produced by CCHIS also are many and varied. Because of this diverse audience, the system will need to be user-friendly and flexible. We plan to use both the SDH intranet as well as the Internet as distribution platforms, supplemented by hard copy reports. Tabular data will be presented in pivot tables to enable users to customize their view of the data, and allow for custom queries and reports of the database, depending on the user's level of access. A GIS will be part of the system and will allow these data to be viewed and analyzed geographically. Some users will need to have the limitations of specific data types explained and the meaning of the information interpreted, while others will be able to do their own independent analysis. Depending on the audience, a varied degree of interpretation and explanation will be provided with the data.

Currently, we are using Microsoft Excel and Access to store data, and are viewing the data with MapInfo Professional (MapInfo, Troy, NY). SDH is moving toward the creation of a single electronic client record using Oracle-based solutions. As the project progresses, this database will greatly enhance the analysis capabilities of the system. Other GIS tools will be evaluated according to their ability to be used by a wide variety of users over the Internet, with the goal of switching to a fully interactive Internet mapping tool in the future. With this capability, many different types of reports are possible depending on the intended audience and the use intended for the information.

Examples of reports that could be generated for various audiences include:

- Reports for board members and health district senior administrators:
  - Summary data, but at any geographical level found to be useful and appropriate.
  - Analysis of trends in demographics, utilization rates, and frequencies of illness, to better target and forecast health service needs.
- Reports for general managers and managers:
  - Individual access to certain views of the data (macro reports, pre-done graphs).
  - User queries to automatically generate graphical or numeric data presentations that help guide planning and evaluation.
- Reports for our partners (other health and human service agencies).
- Reports for the community:
  - For lobbying, advocacy, etc., via hard copy and the Internet (SDH home page).
- Reports/data for researchers.

SDH would be especially interested in the potential for using these data for answering applied research questions and guiding resource allocation within the health service sector.

Progress to Date

Considerable progress has already been made, both in developing and sustaining

partnerships and in acquisition and use of data. The partnership between Public Health Services (PHS) in SDH and the Corporate Information and Technology Branch (CITB) of Saskatchewan Health has been a cornerstone in this project. CITB has been working on a data warehouse project within Saskatchewan Health for several years, bringing together data from various branches within the department. Some of these data were presented to health districts for their use in health planning, aggregated at the district level as a Community Profile. This is quite useful for smaller districts, but less useful for districts with larger populations. Therefore, Saskatchewan Health is providing neighborhood-level data from their data warehouse project to SDH as a pilot project. Once SDH has found the most useful data fields and formats for health status monitoring and health planning, Saskatchewan Health hopes to roll this out to the other health districts as well.

Another key partnership has been between PHS and the University of Saskatchewan's Department of Community Health and Epidemiology. University faculty have helped PHS do background research and develop the conceptual model and evaluation plan. They have also helped in co-authoring grant proposals and articles, and in developing interest in the research community for the potential uses of the CCHIS. This partnership has been critical to helping establish the credibility of the project with our partners.

At appropriate intervals, other partner agencies have been asked to join in the discussions. These include the University of Saskatchewan's Department of Geography, the City of Saskatoon's Planning Department, the Saskatoon Tribal Council, and the Saskatoon Regional Intersectoral Committee (comprised of the provincial Departments of Health, Social Services, Education, and Justice).

Data Acquisition

Data acquisition and management are anticipated to be continuous processes that will include adding data sources and historical data. Currently we have data from the census and vital statistics, as well as data on hospital utilization, the population covered by provincial health insurance, and communicable diseases. Saskatchewan Health and SDH have provided these data primarily at the neighborhood or postal code level, which is more detailed than the district-level data routinely available from the province. Next, we are requesting data on physician services, the prescription drug plan, home care, long-term care, the cancer registry, and mental health.

Selected data from Saskatchewan Education, Saskatchewan Social Services, and Saskatchewan Justice will also be requested. We are also now in the process of adding other public health data, including immunization rates. The aim is to have access to these data at a reasonably detailed level based on certain demographic and geographic variables without it becoming identifiable at the individual level. This can be done by only acquiring the data at a certain level of aggregation, or by only releasing the data in a re-aggregated format but after data linkage has occurred. The latter option would allow for more detailed and robust analysis of associations in time and space between variables in the dataset, beyond purely ecological analysis.

Data linkage can be a time-consuming, error-ridden task. Several initiatives being undertaken in Saskatchewan make this more palatable. The data warehouse project in Saskatchewan Health is already utilizing the health insurance services number (a

unique identifier) for data linkage. Also, SDH is embarking on the task of developing a single patient registration system for use by all services in the district, which will use the same health number as the unique identifier. These initiatives will make data linkage within the health sector much easier. Linkage of data between sectors may be more difficult. We will start with ecological analysis at a relatively small geographic level and work on increased linkage over time. We also hope to incorporate local survey data being collected in the district, as well as qualitative data via a searchable index of keywords.

Roadblocks and Resolutions

We have been proactive in attempting to deal with potential difficulties in this project by meeting with agency leaders to sell the win-win features of partnerships to solve data sharing and project funding issues. We are also

- Highlighting the powerful features of the technology, showing impressive sample output, and telling about the potential for doing detailed forecasting of future needs and demographics.
- Providing reassurance regarding data security features being developed and the ability to either limit release of data when sample size gets small or publish only aggregate data.
- Planning to establish a steering committee and a technical advisory group to guide the project's activities and keep it accountable to all partners and the community via representatives on these committees.

In this manner, the leadership in SDH has been apprised of the full potential of this project and has been very supportive in its establishment. It is envisioned that PHS will continue to be a major provider of data and a major user of the system for program planning and health status reporting. The following examples show how PHS uses these data for enhanced program delivery, as well as to inform its program planning and evaluation:

1. **Low Income and Housing:** Figure 1 illustrates the relationship between poverty, housing density, and control. Areas with a higher proportion of low income tend to be more crowded and have a high proportion of rented housing. Higher income is associated with higher home ownership and less dense housing. These types of data are useful for lobbying efforts of community groups and for directing social and health programming to areas of greatest need. Within public health, our public health inspectors work with municipal fire and building inspectors to try to improve rental housing quality in the neediest areas of the city.

2. **Birth Rate and Income:** Figure 2 shows the relationship between higher teenage mother fertility and low income. This information can be used to direct further study about reasons for disparities between areas (e.g., less access or desire for abortion, less education about birth control, differences in sexual activity), and can ultimately be used to target areas in greater need of these services.

3. **Rates of Hepatitis A and Pertussis:** Figure 3 is a good example of the project's ability to combine or layer multiple data sources. Here we see that Hepatitis A rates are most closely correlated with the distribution of registered Indian
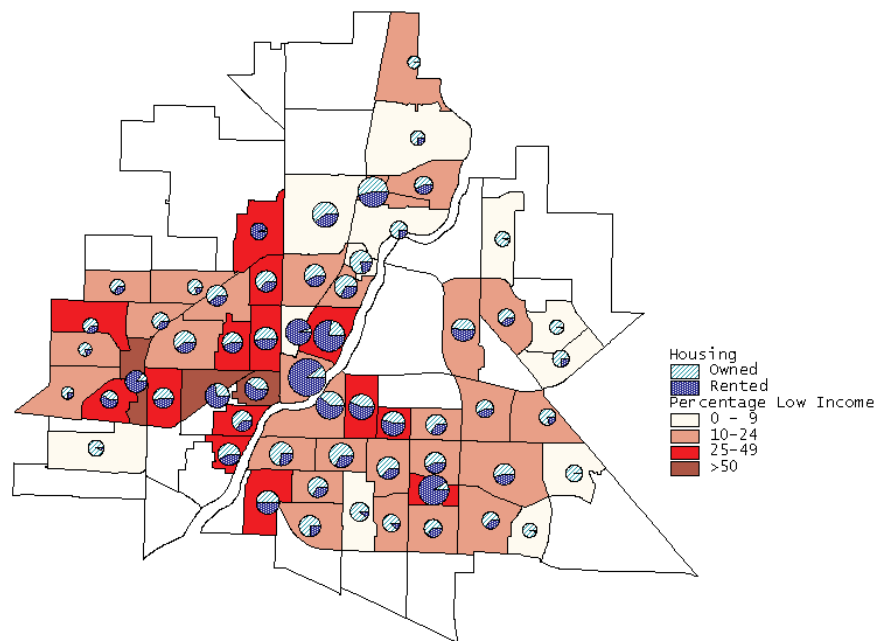
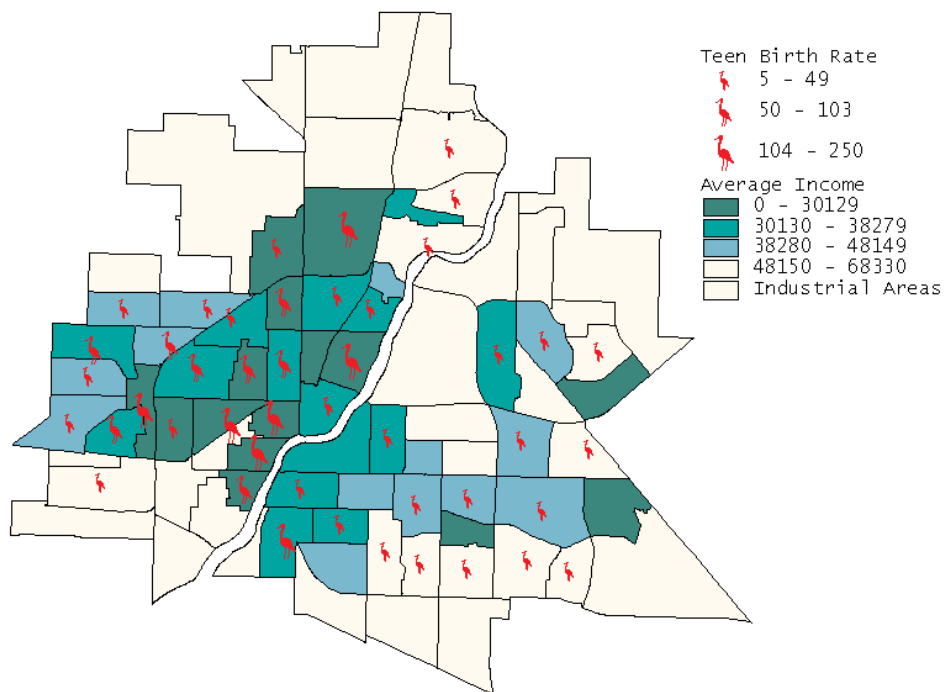**Figure 1**   Percentage of low-income households and home ownership, by neighborhood; Saskatoon, 1991.

Figure 2   Birth rates for 15- to 19-year-old females, by neighborhood income; Saskatoon, 1996.
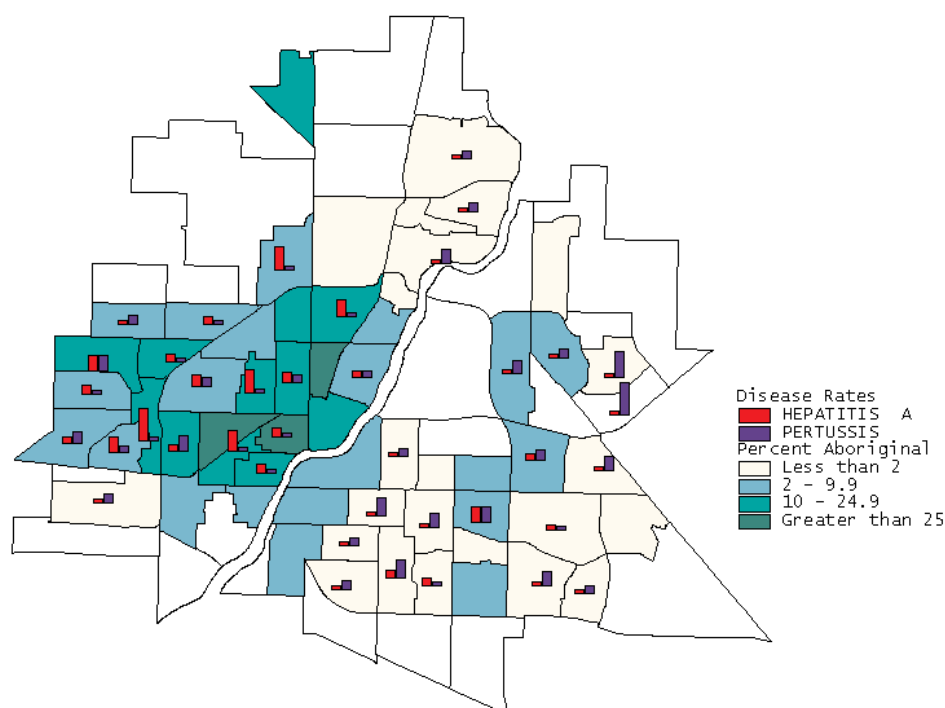
Figure 3   Rates of selected communicable diseases, by average neighborhood income; Saskatoon, 1997.

persons who are more mobile between the city and the reserves where higher Hepatitis A rates are seen. In contrast, Pertussis rates are more evenly distributed in the city. Soon, we will be incorporating street address level mapping to allow us to use this information more effectively for outbreak management.

4. **Cardiovascular Disease Morbidity and Mortality:** Figure 4 shows how hospital utilization data can be contrasted with vital statistics data for targeting prevention programs. Cardiovascular disease shows a certain distribution (after adjusting for age and sex distribution), but mortality rates due to cardiovascular disease show a slightly different pattern. One can use these data to target primary, secondary, and tertiary prevention programs as well as for further studies into what health determinants are causing the difference between mortality and morbidity rates by neighborhood (e.g., access to care, stress, exercise, diet, ethnicity).

Future Plans

It is envisioned that the CCHIS, in association with the Strategic Health Information and Planning Services Department, will maximize the potential for having an impact on regional health program planning and policy-making. Future plans for the project include
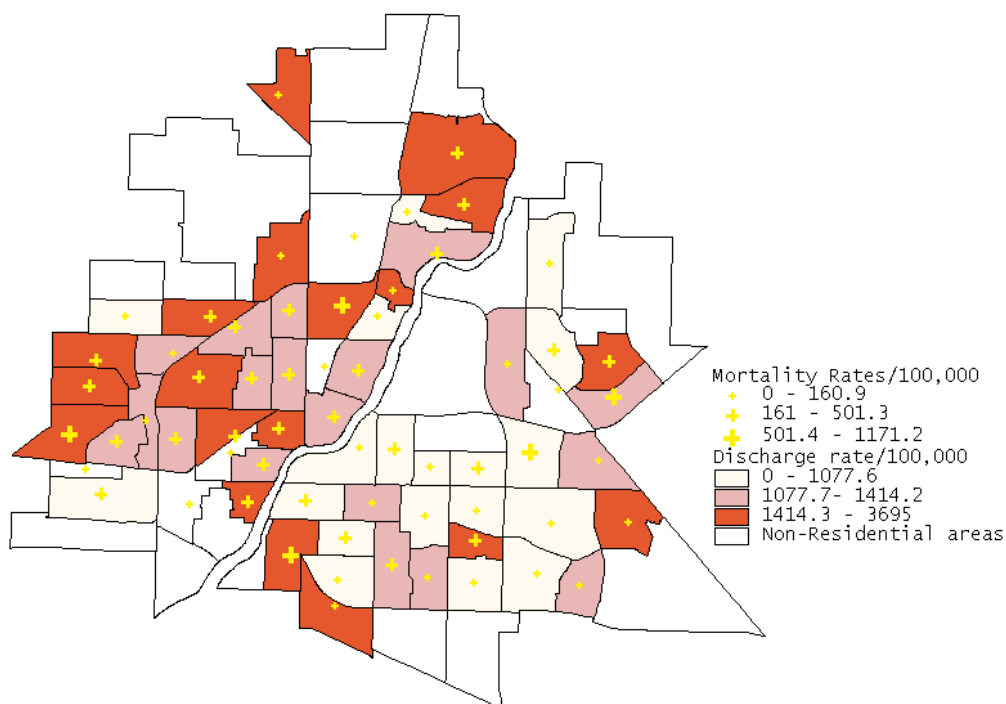
Figure 4   Cardiovascular disease, age/sex standardized rates, by neighborhood income; Saskatoon, 1996.

- Setting up a steering committee and a technical advisory committee.
- Incorporating a format to allow access to reports and data via the Internet.
- Linking databases in real time.
- Increasing data sources (including qualitative data).
- Linking with the SDH's District Client Information System (an electronic health ecord in development).
- Expanding GIS tools and resources, and making this accessible over the Internet and the SDH intranet.
- Training staff in the use of the tools and interpretation of the information.
- Encouraging use of the data and outputs at all levels of the organization and among our partners, including the community.

Summary

In summary, the CCHIS will provide a seamless dataset to a wide variety of users at various levels of aggregation. This relational data warehouse will be comprised of data from various agencies within the health sector as well as other sectors with information to share regarding health determinants. The ability to have access to this comprehensive collection of data to analyze and view using a GIS will greatly enhance health planning, evaluation, and research that will improve service delivery within the health

sector. Intersectoral planning will also be enhanced with data-sharing between various levels of government and those government sectors that have the greatest chance of making an improvement in the health of the population. Lessons learned from this project will be broadly transferable across Canada. Progress to date has been considerable, with much enthusiastic partner support.

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